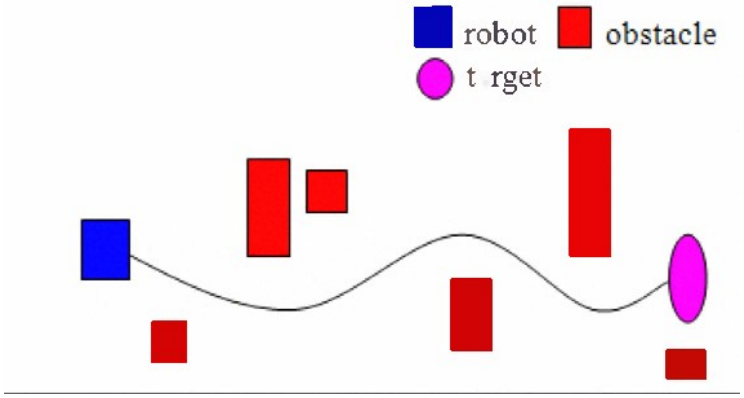
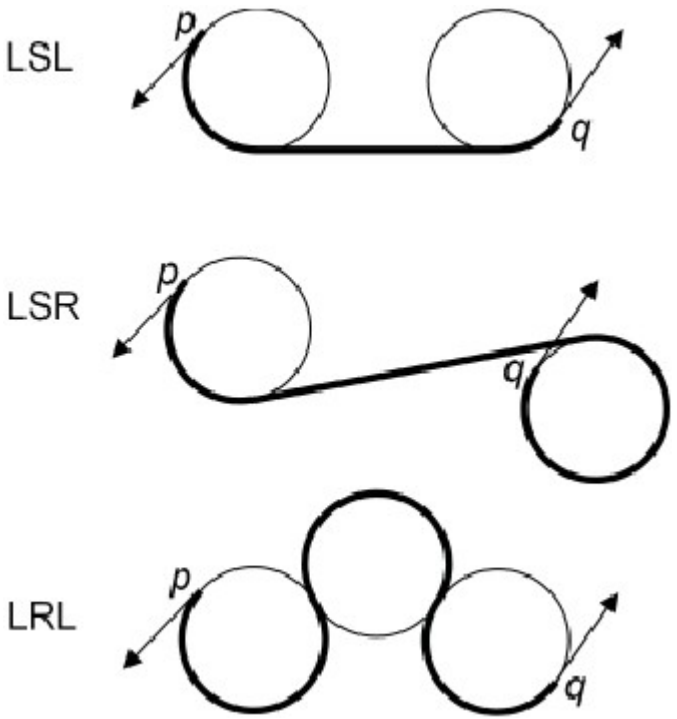
Path following for mobile robots
Guiding Vector Fields (GVF)

Given a desired path, how does a robot follow it?



Following straight lines and circles

Dubin’s path consists of a sequence of lines and circles



Implicit equations of the path

Circle → $f(x,y) := (x-xc)^2 + (y-yc)^2 - r^2 = 0$

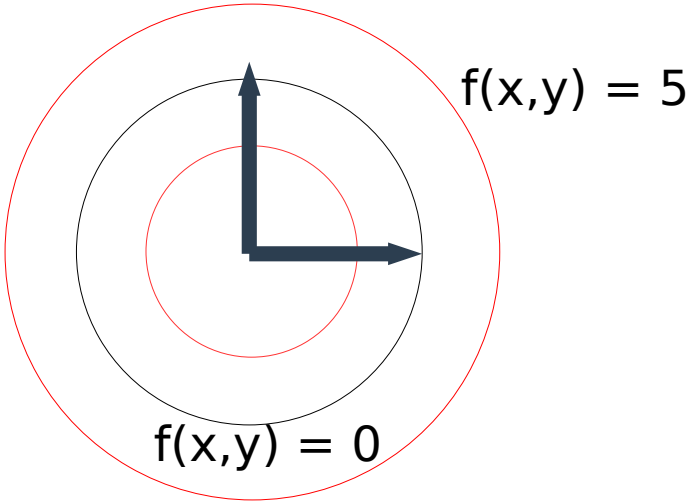
Straight line → $f(x,y) := ax + by + c = 0$

Level sets

$x^2 + y^2 - r^2 = 5$ Outer

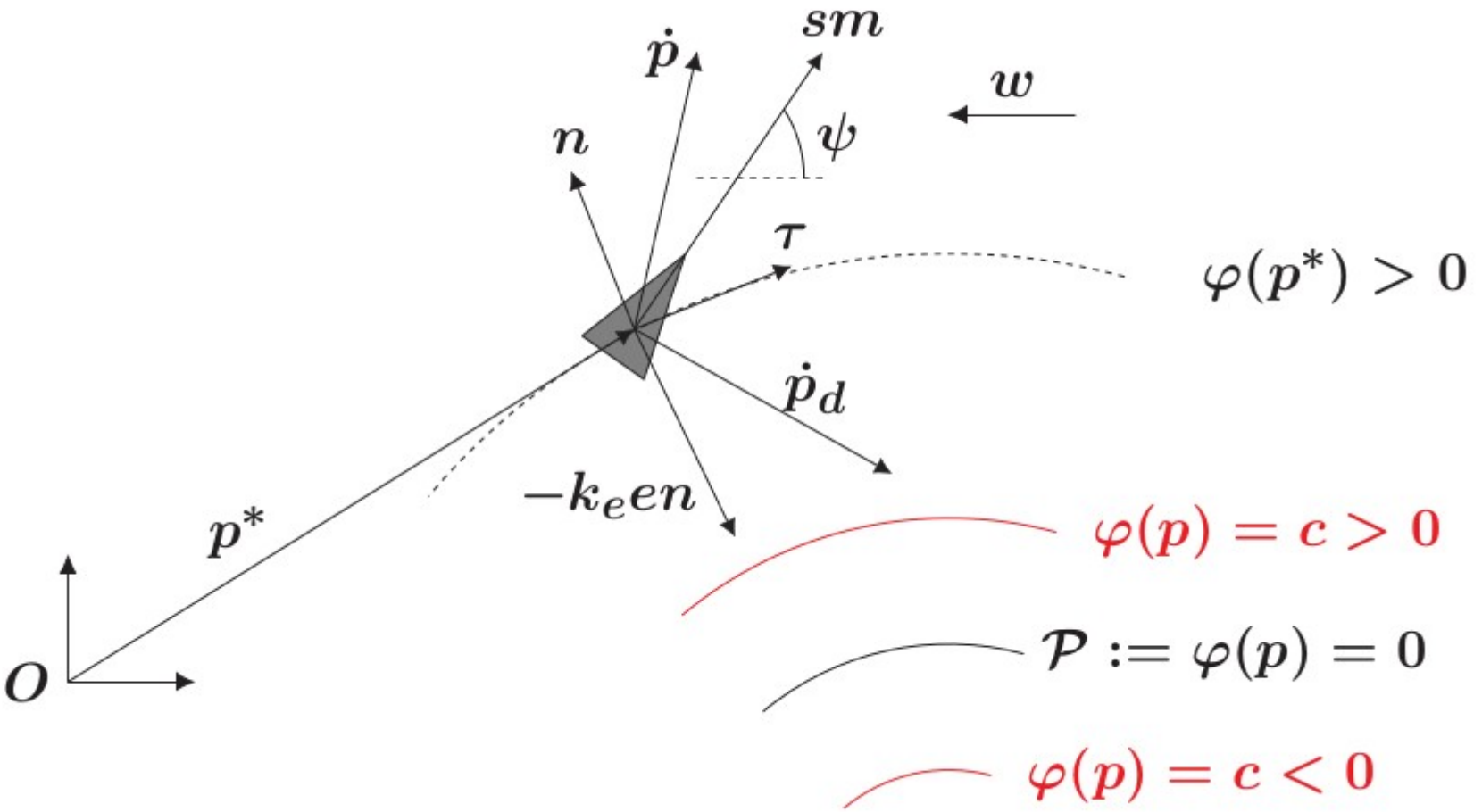
$x^2 + y^2 - r^2 = 0$ Target trajectory

$x^2 + y^2 - r^2 = -5$ Inner



f(x,y) can be used as an error signal!

How to follow the desired trajectory? We need the normal and tangent vectors



We need the Jacobian of the path

Circle → $f(x,y) := (x-xc)^2 + (y-yc)^2 - r^2 = 0$

Straight line → $f(x,y) := ax + by + c = 0$

The Jacobian tells us in which direction the level set grows! (normal to the path)

Jacobian of the circle

Jac = 2[(x-xc) (y-yc)] is the normal vector to the circle

Jacobian of the straight line

Jac = [a b] is the normal vector to the line

We need the tangent to the path

It is just the 90 degrees rotation of the Jacobian

Tangent = Rot(90) Jac

The direction to follow is the combination of the normal and tangent

Control action or direction to follow

e:=f(x,y) (error signal)

Direction to follow = tangent - e*normal

Example with an ellipse